401 KAR 42:060

# CORRECTIVE ACTION PLAN OUTLINE


**ENERGY AND ENVIRONMENT CABINET**
**DIVISION OF WASTE MANAGEMENT**
**UNDERGROUND STORAGE TANK BRANCH**
**200 FAIR OAKS LANE, 2ND FLOOR**
**FRANKFORT, KENTUCKY 40601**
**502-564-5981**
**http://waste.ky.gov/ust**

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**CORRECTIVE ACTION PLAN OUTLINE**

Energy and Environment Cabinet
Division of Waste Management
Underground Storage Tank Branch
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601
502-564-5981
http://waste.ky.gov/ust

## INTRODUCTION

This document shall be used by owners and operators that are required to develop and implement a Corrective Action Plan (CAP) under Kentucky Administrative Regulations 401 KAR 42:060. This outline applies to owners and operators that are required to submit a CAP after the effective date of this administrative regulation. Owners and operators shall submit an original and one (1) copy of a CAP upon written request by the cabinet when the site investigation is determined complete by the cabinet.

The purpose of the CAP is to outline the proposal for remediation of contaminated soils, surface water or groundwater impacted by the UST system release of a regulated substance, outside of the excavation zone, from a regulated UST system. The CAP shall be designed to reduce target chemical constituents to the allowable levels established by the regulations in effect at the time of the submittal of a Notice of Intent to Permanently Close UST Systems Form or release report. This Corrective Action Plan Outline is provided to assist owners and operators in choosing remediation options that are appropriate to the geological and hydrogeological conditions at the site, within the context of the type and extent of contamination present at the site, and in determining whether the remediation options proposed are appropriate for meeting the allowable levels for target chemical constituents established for the site. For terms not defined herein, the definitions in 401 KAR 42:005 shall apply.

This outline provides a general format for preparing a CAP. Some UST facilities and some remediation technologies have unique features that may require additional information. The intent of this outline is to provide the minimum requirements for a CAP.

The cabinet may deny or revoke acceptance of the CAP for any site because of incompleteness of the CAP, or the failure of the owner or operator to demonstrate that the proposed corrective action is appropriate, or the failure to demonstrate that the proposed corrective action will achieve clean-up goals established for the site, or the failure to demonstrate that the proposed corrective action will adequately protect human health, safety, and the environment.

A written request for a final determination on CAP acceptance may be requested in accordance with KRS 224.60-138. See section on “Interim Corrective Action” regarding the ability to perform corrective action prior to CAP acceptance. Upon a final determination of acceptance by the cabinet, owner and operators will receive the cabinet’s written approval.

Pursuant to KRS 322 and KRS 322(A) any work constituting the public practice of engineering or geology, including the development and implementation of the CAP, shall be completed by a Professional Engineer (P.E.) registered with the Kentucky Board of Licensure for Professional Engineers and Land Surveyors, or a Professional Geologist (P.G.) registered with the Kentucky Board of Registration for Professional Geologists and the attached affidavit signed by same.

Pilot studies may be necessary prior to the approval of some corrective action technologies. If it is determined that a pilot study is necessary, a proposal for the pilot study shall be submitted to the cabinet for approval. For tank owners or operators seeking reimbursement from the cabinet for a pilot study, written approval from the cabinet shall be obtained prior to beginning a pilot study.

The CAP shall be, at a minimum, a plan of the proposed corrective actions. This plan shall address the following issues of concern:

- the physical and chemical characteristics of the regulated substance, outside of the excavation zone, including its toxicity, persistence, and potential for migration;
- the geologic and hydrogeologic characteristics of the site and the surrounding area;
- the physical characteristics of all impacted and potentially impacted media at and surrounding the site, including soils, groundwater, surface water, and bedrock;
- the full extent of contamination in all impacted media;
- how the proposed corrective action will remediate the entire extent of contamination to the established site-specific clean up levels, including all media potentially impacted by remediation activities;
- at a minimum, three (3) corrective action technologies must be compared to remediate the contamination. If soil contamination exists, then one of the technologies to be compared must include over-excavation of the source of contamination;
- a proposed time table for the corrective action (benchmarks), including the anticipated time to achieve compliance;
- how the performance of the remediation system is to be evaluated, including a proposed operation and maintenance schedule, what activities will be necessary, and a discussion regarding the necessity of telemetry and unscheduled maintenance;
- the potential effects of residual contamination on nearby surface water and groundwater;
- evaluate and verify site classification per 401 KAR 42:080;
- a Closure Plan (see Section 9.0);
- any other requirements as detailed herein; and
- a proposed cost estimate and preferred method of reimbursement for those eligible parties seeking reimbursement (refer to 401 KAR 42:250 for eligible reimbursement procedures).

All technical issues related to the proposed remediation technology shall be addressed in the CAP. "As built" designs are not required to be submitted with the CAP.

UST facilities with active UST systems that are proposing corrective actions shall perform a tank/line tightness test prior to implementation of correction actions as directed by the cabinet.

**Corrective Action Plan Implementation**

Owners or operators shall begin implementation of the CAP within thirty (30) days of the date of acceptance of the CAP by the cabinet. The cabinet shall be informed in writing of the owner's or operator's intent to implement the CAP at least seven (7) days prior to implementation.

**Public Notice Requirement**

Prior to the implementation of the CAP the owner or operator shall give notice of the proposed action by publishing at least one time, a Public Notice in a newspaper having general circulation in the county where the corrective action is to take place. Two (2) copies of both the invoice and affidavit of publication shall be submitted to the cabinet within seven (7) days of the publication. An example of the Public Notice that shall be completed and published is included at the end of this outline.

The cabinet will determine if a public notice is required for interim corrective action.

**"As Built" Design Requirement**

Within one hundred twenty (120) days of the date of acceptance of the CAP by the cabinet and after installation of the remediation system, an original and one (1) copy of the "As Built" design shall be submitted to the cabinet.

The "As Built" design shall contain all relevant technical information concerning the remediation, including:

- all equipment specifications; note that the plan shall include a discussion on how the system may be affected by the site-specific chemical and physical properties (i.e., grain size, fouling, $CaCO_3$, Fe, etc.);
- Site maps indicating the location of all related remediation equipment (all maps shall be to scale and shall include a north arrow and a legend);
- the position of the remediation equipment relative to the extent of contamination;
- copies of required permits; and
- any other relevant technical information or other information required by the CAP Outline.

**Monitoring Requirements**

Once the CAP has been implemented owners or operators shall submit a quarterly monitoring report of the corrective action activities within thirty (30) days after the close of each calendar quarter. The first quarterly monitoring report shall be submitted within one hundred twenty (120) days of the date of the acceptance of the CAP. An original and one (1) copy of the quarterly monitoring report shall be submitted. Quarterly monitoring reports will be required until the site is closed by the issuance of a No Further Action letter, or as directed by the cabinet.

Quarterly monitoring reports shall include, but are not limited to, the following information:

- a site map with sampling locations labeled with analytical results;
- analytical data sheets and chains of custody;
- groundwater potentiometric surface map;
- description of sample collection and management;
- historical data tables for soil and groundwater contaminants;
- historical data table of monitoring well gauging data

- description of site condition (monitoring well maintenance, cracks in pavement, stained pavement, etc.), including photographs, if necessary;

- system performance evaluations and discussion of performance trends, if applicable;

- effectiveness of corrective action activities;

- a discussion of operation and maintenance activities at the site, scheduled and unscheduled, a description of work completed, and why these activities were necessary (note that if more than 4 unscheduled maintenance events are necessary during a consecutive 12-month period, a re-evaluation of the system will be required);

- description of waste management, storage, and disposal;

- discussion of any trends in data (graphs of contaminant concentrations versus time and groundwater elevations versus time); and

- a conclusions and recommendations section (note that if the approved corrective action technology proves to be ineffective, re-evaluation of the system will be required).

Refer to the Site Investigation Outline (401 KAR 42:060) for more information about monitoring well requirements, data tables, and proper sample collection and management.

The approval letter for the CAP shall document sample collection frequency and monitoring report requirements that may differ from the quarterly requirements outlined above. Deviations in sampling frequency shall be approved in writing by the cabinet.

**Final Closure Requirements**

Once analytical results verify that residual soil and groundwater contamination is below the levels established for the site to achieve final closure, a request for No Further Action shall be included in the last quarterly monitoring report. For final closure the last quarterly monitoring report shall also include, at a minimum, the following:

- maps showing confirmatory soil and/or groundwater sampling locations that demonstrate that the extent of contamination has been remediated to the allowable levels established for the site;

- analytical results for confirmatory soil and/or groundwater samples that demonstrate that the extent of contamination has been remediated to the allowable levels established for the site;

- tables of historical soil and/or groundwater data;

- a discussion of how the corrective action system will be properly removed and managed (if applicable); and

- a conclusions and recommendations section.

For UST facilities with groundwater contamination, final closure shall include, at a minimum, four (4) consecutive quarters of groundwater samples from representative monitoring wells indicating contaminant levels below those applicable to the site, obtained after the corrective action system has been inactive (if applicable).

All monitoring wells not used for post-NFA monitoring, shall be properly decommissioned, upon no further action, according to 401 KAR 6:310.

**Interim Corrective Action**

Pursuant to 401 KAR 42:060, which incorporates 40 CFR 280.66 by reference, owners and operators may, in the interest of minimizing environmental contamination and promoting more effective cleanup, begin cleanup of soil and groundwater before the CAP is accepted provided that the cabinet is notified in writing of the intention to begin cleanup. The cabinet may impose conditions on the implementation of the interim actions. Owners and operators should be aware that certain types of corrective action, or a lack of corrective action measures, may distribute the contamination or allow it to migrate into areas that were not previously affected by the UST system release. For tank owners or operators seeking reimbursement from the cabinet for interim corrective action activities, written approval from the cabinet shall be obtained prior to beginning interim corrective action activities. Interim corrective action proposals shall include an estimate of costs required to complete the corrective action and signed by a P.E. or a P.G.

If over-excavation is proposed to remediate contaminated soil, the interim corrective action proposal shall include:

- a map showing the vertical and horizontal extent of the area to be over-excavated and an estimate of soil to be removed (in tons);
- laboratory results of soil samples analyzed within 12 months prior to the proposed date of over-excavation or as determined by the cabinet;
- the number and locations of confirmatory soil samples (if necessary);
- a discussion on the management of pit water (if water may be encountered);
- an estimate of costs associated with the over-excavation proposal; and
- a discussion of how over-excavation may affect future corrective action activities (e.g., short circuiting of remediation systems that may be used in the future).

Over-excavation activities shall be conducted as follows, unless otherwise directed by the cabinet:

- Representative soil samples from the over-excavation pit walls and floor shall be collected and analyzed for the appropriate constituents, as directed by the cabinet. If bedrock is encountered and floor samples cannot be collected, soil samples from the base of the over-excavation walls at bedrock may substitute for confirmatory floor samples. If buried structures are encountered during over-excavation (e.g., building foundations, buried utilities, etc.), confirmatory samples shall be collected prior to the removal of all soil in order to confirm the presence or absence of contamination;
- Unless an alternate sampling plan is approved, confirmatory soil samples shall be collected within four (4) hours of the termination of excavation activities within each segment of excavated area. Soil samples shall be properly collected, handled, preserved, and analyzed according to SW-846;
- At least one (1) composite sample shall be collected for every 382 cubic meters (500 cubic yards) of excavated material removed from the tank pit or piping trench excavation if the material is to be returned to the excavation, used for an unrestricted off-site purpose, or treated on-site. If the excavated material is to be used for unrestricted off-site use, the material shall be sampled and analytical results shall be below the allowable levels for all constituents listed in Soil Table 3 of the Classification Outline (August 2006). If the

excavated material is to be treated off-site, contact the Solid Waste Branch, Division of Waste Management, 200 Fair Oaks Lane, 2nd Floor, Frankfort, KY 40601 or call 502-564-6716;

- Reuse of excavated backfill material treated off-site (e.g., landfarming, thermal soil desorption, etc.) shall be analyzed for BTEX, PAH and Total Lead. Analytical results shall be below the appropriate levels established in the Classification Outline (August 2006) prior to replacement of any treated backfill material to the area of over-excavation. Laboratory data sheets shall be included in the over-excavation report;

- Reuse of excavated backfill material treated on-site (e.g., landfarming, biocells, etc.) shall be analyzed for the appropriate constituents listed in Table A of the Site Investigation Outline (August 2006), incorporated by reference in 401 KAR 42:060, or in Table A in the Closure Outline (August 2006), incorporated by reference in 401 KAR 42:070. Analytical results shall be below the appropriate levels established in the Classification Outline (August 2006) prior to replacement of any treated backfill material to the area of over-excavation. Laboratory data sheets shall be included in the over-excavation report;

- Open pit management and safety is the responsibility of the tank owner/operator during over-excavation activities (or any site activity that involves soil removal).

Over-excavation reports shall, at minimum, include:

- a narrative describing soil removal activities, photographs of field work, an indication of the presence or absence of water in the over-excavation, and the volume of water removed, if encountered;

- analytical results and chains-of-custody for confirmatory soil samples, groundwater/pit water results, and a table for soil data that summarizes the sample name, date sampled, and analytical results for each constituent;

- a map showing the former UST system location, previous soil and groundwater sampling locations, and the over-excavation area superimposed with confirmatory soil sample locations labeled; and

- a recommendations and conclusions section by a P.E. or P.G. if contamination remains above allowable levels.

If free product is *initially* discovered during corrective action activities, contact the UST Branch for a determination of necessary action (see 401 KAR 42:250 for eligible reimbursement procedures).

**Reimbursement Procedures**

Owners or operators seeking reimbursement from the cabinet for corrective action or interim corrective action work shall follow 401 KAR 42:250. For questions about reimbursement, contact the UST Branch's Claims and Payment Section at 502-564-5981.

## PART I. CORRECTIVE ACTION PLAN OUTLINE: GENERAL REQUIREMENTS

If the information required below has previously been submitted to the cabinet (e.g., in the Site Investigation and Closure Assessment reports, or other reports) this same information is not required to be resubmitted. References to information previously submitted (i.e., the name and date of the report, and the page numbers where the relevant information is located) shall be indicated in the CAP and on the CAP checklist.

### 1.0 SITE IDENTIFICATION, LOCATION AND HISTORY

**1.1** Provide the name and location of the property including the street address, city, county, and Agency Interest number.

**1.2** Provide a summary of all commercial and private activities that have been conducted at the site.

**1.3** Provide the tank owner's name, address, and telephone number. Include the operator's and/or the property owner's name, address, and telephone number, if different from the tank owner's.

**1.4** Provide a USGS topographic map depicting the location of the site. The map shall also indicate the surrounding properties and the nearest town, city, or community. Provide the USGS topographic quadrangle name in which the site is located.

**1.5** Provide a detailed, site-specific map. The site map shall include a scale, north arrow, and legend. The site map shall illustrate tank and piping locations, the location and depth of all tank pits, the locations of property boundaries, adjacent properties and their land use, as well as other pertinent features. The estimated boundaries of the contamination shall be identified on the site map. The map shall also include any underground utility lines, indicating the type of service and the depth of the line. Site maps shall include all sampling locations, all monitoring locations (including groundwater, surface water, sediment, and air), the locations of all parts of any existing or proposed remediation system(s) including extraction wells, infiltration galleries, injection points, sparge nodes, soil vents, trenches, piping, pumps, scrubbers, separators, electrical conduits, or other equipment pertinent to the remediation system(s).

**1.6** Provide original site photographs with descriptive captions, including features pertinent to the remediation activities at the site, in the original CAP report submitted to the cabinet. The use of color photocopies of the original photographs will be acceptable in any additional copies of the CAP report required to be submitted.

**1.7** Provide information on local population demographics of the area around the site, including information regarding land use on site and in the immediate surrounding area.

**1.8** Provide a summary of the average monthly precipitation for the site from available sources (e.g., Western Kentucky University's Climate Center can be accessed at http://kyclim.wku.edu/climate).

### 2.0 SUMMARY OF SITE INVESTIGATION (S)

**2.1** Provide the date(s) of any regulated substance UST system release(s), or the date(s) of the discovery of any such UST system release(s), and the type and amount of product released.

**2.2** Provide a summary of any emergency situations that have occurred as a result of the UST system release of a regulated substance, such as fumes in homes, businesses,

sewers, caves, etc., drinking water wells or lines impacted, explosions, fires, or any other emergency requiring a response. If ERT report(s) were filed relating to this UST system release, summarize and provide the incident numbers for each report.

**2.3** Provide a description of the contaminants present and assess the degree of weathering of the product, if possible. The description shall include color and odor of contamination encountered, and shall include analytical profiles of the constituents of the contamination, if available.

**2.4** Provide a summary of any actions taken to abate the UST system release, methods used for free product recovery, and the amount of free product recovered.

**2.5** Provide a description of methods currently being used to control migration of the contaminant plume(s).

**2.6** Provide a summary of the results of the site investigation. This summary shall include a detailed map of the site illustrating the local topography and indicating the locations of sampling points, borings, and monitoring wells. Indicate groundwater flow direction, if applicable. A summary of laboratory and field sample analyses and "quality assurance/quality control" (QA/QC) data shall also be submitted.

**2.7** Provide a map and cross sections constructed from soil borings and/or monitoring well borings, illustrating the horizontal and vertical contaminant gradients (e.g., isochem contours) at the site.

**2.8** Provide a chronological description of all site investigation and corrective action activities conducted to date.

## 3.0 ADDITIONAL SITE CHARACTERIZATION

**3.1** Provide a summary of any other physical, chemical, or biological data obtained as part of the site investigation, for example, soil porosity and permeability data, soil moisture data, soil gas data (e.g., $CO_2$, $O_2$, $H_2S$), physicochemical data, for example: pH, Eh, soil and groundwater microbe enumeration studies, biomass calculations, or other information gathered that may be applicable, or necessary, for individual corrective action technology applications at the site.

**3.2** Provide the results of any pumping tests, slug tests, or other aquifer tests conducted to characterize the groundwater at this site.

**3.3** Provide the results of any other tests or analyses conducted to define the horizontal and vertical extent of contamination or to further characterize the site in order to determine the applicability or practicality of any specific remediation technology.

## 4.0 SOIL AND GROUNDWATER CORRECTIVE OBJECTIVES

**4.1** Provide the applicable proposed cleanup levels for soils at the site. These target levels shall be based on levels specified in the Classification Outline (August 2006). Include a completed, signed, and dated copy of the Classification Guide DEP8056/01/06, indicating the Class and soil cleanup levels under which this site shall achieve no further action (if applicable).

**4.2** Provide the applicable cleanup levels for groundwater as determined from the Groundwater Worksheet in the Classification Outline (August 2006), Groundwater Worksheet, incorporated in 401 KAR 42:080.

## 5.0 COMPARATIVE TECHNOLOGIES AND CORRECTIVE ACTION

**5.1** Provide a summary of any alternative technologies given preliminary consideration for remediation at this site. The summary shall include a discussion of the applicability of the remediation considered, the ability to treat contaminants at the site given the contaminant and site conditions, the potential effectiveness of each technology given consideration, and why each technology was rejected as an alternative.

**5.2** Provide a summary of any cost-effectiveness studies conducted on technologies given consideration as well as for selected technologies.

## 6.0 SELECTED TECHNOLOGIES AND CORRECTIVE ACTION

**6.1** Provide a summary of the technology (or technologies) selected for remediation at the site and include a discussion of the criteria used to select this technology (e.g., time required for the treatment, ability to achieve cleanup levels, etc.).

**6.2** Provide a schematic summary of the design and operation of the selected technology including a description of equipment, operating and monitoring requirements, and methods used to control discharges of air and/or water. This is intended to be a working conceptual plan and not an "as built" design.

## 7.0 PILOT STUDIES

**7.1** Provide a summary of the results of any pilot studies conducted, or models constructed, for any technology that was selected for site remediation, including field or laboratory data demonstrating that the technology can be expected to result in cleanup of the contamination. Data for pilot studies shall be provided in an appendix. For tank owners or operators seeking reimbursement from the cabinet for a pilot study, written approval from the cabinet shall be obtained prior to beginning a pilot study.

**7.2** Provide a summary of the results of any pilot tests conducted on other technologies not selected for remediation at the site, which shall include field or laboratory data demonstrating why that technology cannot effectively reduce contaminant concentrations at the site to maximum allowable contaminant levels in soil and groundwater. Data for pilot studies shall be provided in an appendix. For tank owners or operators seeking reimbursement from the cabinet for a pilot study, written approval from the cabinet shall be obtained prior to beginning a pilot study.

## 8.0 MONITORING PLAN AND TIME TABLE FOR REMEDIATION

**8.1** Provide a monitoring plan that shall include:

a) a description of the parameters in soil and/or groundwater to be sampled (e.g., contaminant concentrations, soil-gas, soil pore-water and groundwater chemistries such as pH, Eh, $O_2$, COD) or other methods for determining corrective action efficacy at the site;

b) the locations of sampling points (e.g., monitoring wells, soil borings, soil gas surveys) that will be used to determine the location of and the extent of the contaminant plume(s), and the levels and activity within the contaminant plume;

c) a schedule for sampling selected parameters, including target contaminant concentrations, on a frequency sufficient to determine changes in contaminant levels and potential or real plume migration; at a minimum, required monitoring shall be conducted on a quarterly basis;

d) pursuant to 40 CFR 260.11, recognized methods in accordance with US EPA SW-846. These methods shall be followed for sample collection, sample preservation, sampling equipment, decontamination procedures, sample containers, sample size, maximum sample holding times, and sample analysis methods. Samples shall be delivered to an appropriate materials testing laboratory for the analysis required. The date the sample was collected, received, and analyzed by the laboratory, as well as all the US EPA SW-846 methods used to extract and analyze the sample, shall be indicated on the laboratory report. Refer to the Site Investigation Outline (August 2006), incorporated by reference in 401 KAR 42:060, for the appropriate maximum acceptable reporting limits for target chemical constituent analytes.

e) chain-of-custody procedures. These procedures shall be followed to ensure the validity of all samples. The monitoring plan shall include the submittal of the chain-of-custody documentation that identifies who has had possession of the sample, the time of possession, where the sample has been from the time it was collected until the laboratory accepts it, the method of preservation, and the temperature at which the samples were received by the laboratory. If the chain-of-custody is not maintained, e.g., if someone leaves a sample unattended, the integrity of the sample is compromised. The chain-of-custody shall follow all US EPA SW-846 requirements and shall be attached to all sample analyses results submitted;

f) a plan of action if the plume is determined to have migrated beyond predetermined limits during corrective action and monitoring activity; and

g) a proposed time table for remediation, including proposed benchmarks delineating progress toward achieving the clean-up goals established for the site.

**8.2** Provide estimates of the rate of contaminant recovery expected from soil and/or groundwater based on pilot studies, mass balance projections, comparative analysis, or other available information. Tabulations and calculations performed to make these estimates shall be provided in an appendix.

**8.3** Provide a timetable for establishing and meeting corrective action and no further action objectives. Note that the first quarterly monitoring report shall be submitted within 120 days of the date of issuance of a letter by the cabinet notifying the owner or operator of the acceptance of the CAP. Quarterly monitoring reports are to be submitted, minimally, on a quarterly basis.

## 9.0 CLOSURE PLAN

A Closure Plan shall be included in the CAP. The Closure Plan shall include, but is not limited to:

- maps of proposed sampling locations that will determine that the extent of soil and/or groundwater contamination has been remediated to the allowable levels established for the site;

- proposal that all monitoring wells, which will not be used for post-NFA monitoring, will be properly decommissioned, upon no further action, according to 401 KAR 6:310; and

- a demonstration that contamination has not occurred due to migration of contamination and/or the production of degradation products.

## 10.0 WASTE HANDLING, DISCHARGE, AND DISPOSAL

**10.1** Provide copies of any discharge permits (or applications, or a plan to submit any required permits) required to perform the proposed corrective action(s), including pollution control permits, permits to discharge water to a local sewer, a local stream, or other body of water (Kentucky Pollutant Discharge Elimination System (KPDES)). Also, outline all anticipated discharge and disposal activities as a result of corrective action for this site.

**10.2** Provide a plan for the proper disposal of any contaminated soils, residual tank materials, carbon filtration materials, residual waters, absorbent materials, or other materials generated as a function of the corrective action that require proper disposal.

**10.3** Provide a plan to submit all disposal receipts and manifests (if applicable) for all material generated and disposed of during corrective action activities and/or monitoring.

**10.4** All submitted reports shall include the amount of containerized waste generated and disposed.

## 11.0 OFF-SITE ACCESS

Provide copies of signed contracts or other written agreements for permission to access and perform corrective actions on properties other than the property owned by the owner or operator of the underground storage tank system in consideration.

**11.1** If soil and/or groundwater contamination extends off-site, contamination on adjacent properties shall be addressed. If an off-site property owner denies property access, a written denial must be submitted to the UST Branch.

**11.2** If a written denial is not obtained, a certified letter requesting off-site access must be sent to the off-site property owner with a 14-day response deadline. If there is no response from the off-site property owner, then one additional certified letter must be sent with a 14-day response deadline. If there is no response to the second certified letter, submit both copies of the off-site access request letters with the certification of delivery cards to the UST Branch. Provide the off-site property owner's name, mailing address, and telephone number(s) to the UST Branch.

## 12.0 TECHNOLOGY-SPECIFIC CHECKLISTS AND CERTIFICATION AFFIDAVITS

**12.1** Complete and submit all relevant checklist(s) and required information, specific to each technology, to be used as part or all of the remediation activities at the site.

**12.2** Submit the certification affidavit to be completed, signed, stamped, and dated by the P.E. or P.G. certifying the CAP and the information contained therein.

**12.3** Submit the completed affidavit to be signed by the owner or operator and notarized.

## 13.0 PUBLIC NOTICE AND AFFIDAVIT

**13.1** The CAP shall include a plan to publish the public notice of proposed corrective action in a newspaper with general circulation in the county where the remediation is to take place, upon acceptance of the CAP by the cabinet.

**13.2** The CAP shall include a plan to submit to the cabinet, in writing, a letter stating the intent of the owner or operator to implement the CAP that has been accepted by the cabinet.

## 14.0 "AS BUILT" PLAN

The CAP shall include a plan to submit to the cabinet within one hundred twenty (120) days of the date of acceptance of the CAP by the cabinet and after installation of the remediation system, an "As Built" design that includes all remediation and related equipment specifications, a site map indicating the location of the remediation equipment relative to the extent of contamination, copies of required permits, and any other relevant technical information.

## 15.0 SUBMITTAL OF THE CORRECTIVE ACTION PLAN (CAP)

An original and one (1) copy of the CAP, including all relevant information and completed checklists shall be submitted within the timeframe indicated in the written acceptance of the site investigation by the cabinet.

## 16.0 OTHER CONSIDERATIONS

- The owner/operator/contractor/consultant bears the responsibility of exploring, identifying and addressing all potential safety hazards throughout the course of their work.
- The cabinet reserves the right to require additional information. The owner/operator will be contacted, in writing, by the cabinet if more information is required.
- Refer to the Classification Outline (August 2006), which is incorporated by reference in 401 KAR 42:080 for additional information.
- For information about financial assistance for remediation, contact the UST Branch's Claims and Payments Section at 200 Fair Oaks Lane, 2nd Floor, Frankfort, Kentucky 40601 or call 502-564-5981.

**FINAL CORRECTIVE ACTION PLAN (CAP) REVIEW CHECKLIST** (page 1)

The Final CAP Review Checklist is intended to aid the owner or operator and consultant in determining whether all the information required in the CAP is present. In addition, the intent of this checklist is to expedite review of the CAP by the cabinet. If the information required below has previously been submitted to the Cabinet (e.g., in the Site Investigation and Closure Assessment reports, or other reports) this same information is not required to be resubmitted. The location of the information previously submitted (i.e., the name and date of the report, and the page numbers where the relevant information is located) shall be indicated in the CAP and on the CAP checklist.

**Site Name**_____ **County**_____

**Location**_____

**Agency Interest #** _____

**Instructions:**

Indicate the page number next to the item included in the CAP report. Address any items not checked in the body of the report within the specific section. The complete checklist shall be submitted with each copy of the final report in order to expedite review of the CAP.

Page # **1.0 SITE IDENTIFICATION, LOCATION AND HISTORY**

____ 1.1 Site name, street address, city, county, and Agency Interest number.
____ 1.2 Provide a summary of all commercial and private activities that have been conducted at the site.
____ 1.3 Site owner's, operator's and property owner's name, address, and telephone number.
____ 1.4 Site topographic map for exact location of the site (including a scale, a north arrow, legend, USGS quadrangle name, etc).
____ 1.5 Detailed, site-specific map(s) for site location and information regarding the site (including scale, north arrow, legend, and locations of all pertinent features).
____ 1.6 Original site photographs with descriptive captions.
____ 1.7 Information on populations and land use for the site and the surrounding area.
____ 1.8 Provide a summary of the average monthly precipitation.

**2.0 SUMMARY OF SITE INVESTIGATIONS**

____ 2.1 Date of UST system release(s) or UST system release discovery, type and amount of product released.
____ 2.2 Summary of emergency situations as a result of a UST system release (e.g., explosions, fires, fumes, etc.). Provide ERT reports and incident numbers.
____ 2.3 Description of contaminants present at site and an assessment of the degree of weathering.
____ 2.4 Summary of abatement actions, free-product recovery summary.
____ 2.5 Description of methods used to control contaminant plume migration.
____ 2.6 Summary of site investigation, including the site map with sampling locations, borings, and monitoring wells. A summary of lab and field analyses, and QA/QC data.
____ 2.7 Site map and cross-sections illustrating horizontal and vertical extent of contamination.
____ 2.8 Provide a chronological description of all site investigation and corrective action activities conducted to date.

**3.0 ADDITIONAL SITE CHARACTERIZATION**

____ 3.1 Summary of subsurface characterization conducted for prospective corrective action technologies.

____ 3.2 Results of any pumping tests, slug tests, or other aquifer tests and characterization conducted.

____ 3.3 Results of any other tests, models, or analyses used to characterize the site relative to specific corrective action.

**4.0 SOIL AND GROUNDWATER CORRECTIVE ACTION OBJECTIVES**

____ 4.1 Summary of cleanup levels for soils at the site, including a completed, signed, and dated Classification Guide, indicating soil closure class as required by 401 KAR 42:080.

____ 4.2 Summary of cleanup levels for groundwater, including a completed, signed, and dated copy of the groundwater worksheet checklist, as included in 401 KAR 42:080.

**5.0 COMPARATIVE TECHNOLOGIES AND CORRECTIVE ACTION**

____ 5.1 Summary of the preliminary alternative technologies considered for remediation, including a discussion of contaminant conditions, applicability of the technologies and their treatability of contaminants, potential effectiveness, and a discussion as to why the technologies were rejected.

____ 5.2 Summary of any cost-effectiveness studies conducted.

**6.0 SELECTED TECHNOLOGIES AND CORRECTIVE ACTION**

____ 6.1 Summary of proposed technology or technologies.

____ 6.2 Schematic summary of the design and operation of the remediation system.

**7.0 PILOT STUDIES**

____ 7.1 Summary of the results of any pilot test conducted on proposed corrective action technologies.

____ 7.2 Summary of the results of any pilot test conducted on alternative technologies not proposed.

**8.0 MONITORING PLAN AND TIME TABLE FOR REMEDIATION AND NO FURTHER ACTION**

____ 8.1 Monitoring plan for the site, including quarterly reports, sampling parameters, sampling locations, sampling schedules, sampling methods and procedures, and alternative plan of action.

____ 8.2 Estimate of the rate of recovery of contaminants from the soil and/or groundwater.

____ 8.3 Time table for establishing and meeting corrective action and no further action objectives.

**9.0 CLOSURE PLAN**

____ 9.0 Submit a proposed Closure Plan that identifies how remediation of soil and/or groundwater contamination to the allowable levels established for the site will be confirmed and that monitoring wells will be decommissioned properly.

**10.0 WASTE HANDLING, DISCHARGE, AND DISPOSAL**

____ 10.1 Copies of, applications for, or plans to submit copies of any discharge permits required for no further action and/or remediation at the site.

____ 10.2 Plan for disposal of soils, residual tank materials, absorbent materials, or other wastes generated during no further action/remediation that require proper disposal.

____ 10.3 Plan to submit all waste disposal manifests and receipts.

____ 10.4 All submitted reports shall include the amount of containerized waste generated and disposed.

**11.0 OFF-SITE ACCESS**

____ 11.0 Copies of contracts, memoranda of agreement, etc., allowing permission to the owner or operator or their agent to access and/or perform any required corrective action off-site.

**12.0 TECHNOLOGY-SPECIFIC CHECKLISTS AND CERTIFICATION AFFIDAVITS**

____ 12.1 Submit the appropriate checklists for each corrective action technology to be employed at the site.

____ 12.2 Submit the certification affidavit to be completed by the registered Professional Geologist or registered Professional Engineer.

____ 12.3 Submit the owner or operator's affidavit, signed and notarized.

**13.0 PUBLIC NOTICE AND AFFIDAVIT**

____ 13.1 Plan to complete and submit a public notice.

____ 13.2 Plan to submit a notice to the Cabinet of the intent to implement the CAP.

**14.0 "AS BUILT" DESIGN**

____ 14.1 Plan to submit one (1) original and one (1) copy of the "As Built" design to the Cabinet within one hundred twenty (120) days of the date of acceptance of the CAP by the Cabinet and after installation of the remediation system.

**15.0 SUBMITTAL OF THE CORRECTIVE ACTION PLAN (CAP)**

____ 15.0 An original and one (1) copy of the complete CAP shall be submitted with the Agency Interest number on the front page of each document.

## CERTIFICATION OF THE CORRECTIVE ACTION PLAN

Under the requirements of KRS Chapter 322 and 322A, this CAP report shall be completed and signed by a PE registered with the Kentucky State Board of Licensure for Professional Engineers and Land Surveyors or a PG registered with the Kentucky Board of Registration for Professional Geologists.

**I, the undersigned, under penalty of law, and in accordance with the provisions of KRS Chapter 322 or KRS Chapter 322A, as appropriate, hereby certify that the information submitted herewith, including all attached documents, is true, accurate, and complete. KRS 224.99-010(4) provides for penalties for submitting false information, including the possibility of fine and imprisonment.**

Name and Title (Type or Print):

_____

Signature/Date:

_____

Registration Number, Date and Seal:

_____

SEAL

## PART II. TECHNOLOGY-SPECIFIC REQUIREMENTS

This section is designed to aid owners and operators and their consultants in determining whether each technology proposed for remediation at the site has been sufficiently evaluated for its applicability to site conditions and the full extent of contamination, and whether the CAP is complete. Technology-specific checklists are intended to aid owners and operators and their consultants in evaluating the completeness of the CAP. In addition, the CAP technology-specific checklists are intended to expedite review of the CAP by the cabinet. The appropriate checklist for each proposed corrective action technology shall be completed and submitted with the CAP.

System-specific information (e.g., equipment and operations specifications) is not required in the CAP. The CAP Outline is intended to aid owners and operators and their consultant in developing a reasonable and applicable "working schematic plan" or "conceptual model" that is based on sufficient information to substantiate the applicability of the proposed remediation to the site.

If any technology to be used is an "innovative" technology (i.e., no technology-specific checklist is presented in the CAP Outline for the technology), the innovative technology checklist and any other relevant technical information regarding the proposed technology shall be completed and submitted with the CAP.

Checklists in this outline include:

- Soil Vapor Extraction (SVE) CAP Checklist
- Pump and Treat CAP Checklist
- Dual-Phase Extraction (DPE) CAP Checklist
- Air Sparing CAP Checklist
- Thin-spreading of Petroleum-Contaminated Soils CAP Checklist
- Low Temperature Thermal Desorption (LTTD) CAP Checklist
- Innovative Corrective Action Technologies CAP Checklist
- Bioventing CAP Checklist
- Site-Specific Risk Assessment CAP Checklist
- Residual Landfill CAP Checklist
- Enhanced Bioremediation as an Option for Corrective Action
- Monitored Natural Attenuation (MNA) Checklist

## Soil Vapor Extraction (SVE) CAP Checklist

**Overview**

Soil vapor extraction (SVE), also known as soil venting or vacuum extraction, is an *in situ* corrective action technology that reduces concentrations of volatile constituents in petroleum products adsorbed to soils in the unsaturated (vadose) zone. In this technology, a vacuum is applied to the soil matrix to create a negative pressure gradient that causes movement of vapors toward the extraction wells. Volatile constituents can be readily removed from the subsurface through extraction wells. The extracted vapors shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality. This technology is commonly implemented as a dual-phase extraction (groundwater and soil air) using pump and treat technology or used as dual-phase extraction using a "liquid ring" pump.

SVE technology has been proven effective in reducing concentrations of volatile organic compounds (VOCs) and certain semi-volatile organic compounds (SVOCs) found in petroleum products at UST facilities. SVE is generally more successful when applied to more volatile petroleum products such as gasoline. Diesel fuel, heating oils, and kerosene, which are less volatile than gasoline, are not readily treated by SVE but may be suitable for removal by other means (e.g., bioventing).

A Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

This checklist is provided to help evaluate the appropriateness of SVE to the remediation of the contamination at the site, to ensure the completeness of the CAP, and to expedite the review process. Submit the completed checklist with the CAP. Additional information may be required to determine if SVE will accomplish cleanup goals at this site, or a re-evaluation of alternative technologies may be required prior to submitting the CAP.

Answer the following questions and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

**Permeability of Soil**

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | What is the intrinsic permeability of the soil? |
| _____ | ____ | What is the depth to groundwater? (If less than three (3) feet, this parameter alone may not negate the use of SVE. However, provisions for use of a surface seal, construction of horizontal wells, or for lowering the water table shall be incorporated in the CAP.) |

**Contaminant Constituent Volatility**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the vapor pressure of each target contaminant? |
| _____ | ____ | What, if applicable, is the type of enhancement to be used to increase the volatility of target contaminants (e.g., heated air injection)? |
| _____ | ____ | What are the boiling points of the target contaminants? |
| _____ | ____ | What is the Henry's Law constant for each target contaminant? |

**SVE System Design**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the radius of influence (ROI) for the proposed extraction wells? |
| _____ | ____ | What is the ROI calculated for each soil type at the site? (Include calculations in an appendix.) |
| _____ | ____ | What are the proposed extraction flow rates? (Proposed extraction flow rates should achieve likely cleanup in the time allotted for remediation.) |
| _____ | ____ | What types of wells (horizontal or vertical) are proposed for the site? |
| _____ | ____ | Given the ROI for soil types and the area to be remediated, is the proposed well density appropriate? |
| _____ | ____ | What are the proposed well-screen intervals and do they match the soil conditions at the site? |
| _____ | ____ | What, if applicable, is the component proposed to intercept condensation or product (e.g., knockout pots) ahead of the blower? |
| _____ | ____ | What precautions have been taken to prevent static buildup, static discharge, flashing, explosion, and fire? |

**Optional SVE Components**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What type of inlet wells are proposed (e.g., air injection or passive)? |
| _____ | ____ | Is the proposed air injection/inlet appropriate for the site? |
| _____ | ____ | Are surface seals proposed? |
| _____ | ____ | Are the sealing materials proposed appropriate for the site? |
| _____ | ____ | Will groundwater table depression be necessary? |
| _____ | ____ | If groundwater table depression is necessary, are the pumping wells correctly spaced? |

_____ ____ If groundwater is being discharged, is it necessary to treat the groundwater?

_____ ____ Have water discharge permits been obtained for water exiting discharge wells or the treatment process?

_____ ____ Is a vapor treatment system required?

_____ ____ If a vapor treatment system is required, is the proposed system appropriate for contaminant concentration at the site?

_____ ____ If necessary, have air discharge permits been acquired?

**Operation and Monitoring Plans**

**Answer** **Page #**

_____ ____ Does the CAP propose daily monitoring for the first 7 to 10 days of flow measurements, vacuum readings, and vapor concentrations from each vapor extraction well, the manifold, and the effluent stock?

_____ ____ Does the CAP propose weekly to monthly monitoring of flow measurements, vacuum readings, and vapor concentrations from each vapor extraction well, the manifold, and the effluent stack?

_____ ____ Does the CAP propose that manifold valve adjustments be performed throughout the operation of the system to ensure unit stabilization and equitable vacuum extraction from each extraction well?

_____ ____ Does the CAP propose to submit monitoring reports on at least a quarterly basis? The first quarterly report shall be submitted to the cabinet within 120 days after the issuance of a letter by the UST Branch accepting the submitted CAP.

**Closure Plan**

**Answer** **Page #**

_____ ____ Does the CAP Closure Plan provide for testing soil-gas contaminant levels after the system has been shut down for a period sufficient to ensure that adsorbed phase contaminants will re-equilibrate with soil gases?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory soil samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting soil samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination be sufficiently sampled to determine that contamination in the soils has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include sampling locations at a distance sufficient from extraction wells to examine the perimeter effectiveness of each extraction well?

## Pump and Treat CAP Checklist

### Overview

Pump and treat technology is commonly used to control plume migration and to remove groundwater from the subsurface. In this technology, a vacuum is applied via pumping below the saturated zone creating drawdown of the local groundwater table or piezometric surface and causing groundwater to move into the extraction wells. Contaminated groundwater can be readily removed from the subsurface through extraction wells then treated, as necessary, and discharged to streams, sewer lines, etc. or disposed at a proper site.

This technology is used to remove and treat most types of petroleum contamination, as well as other hazardous contaminants with groundwater. Pump and treat technology has been shown to be applicable at UST facilities in controlling plume migration and in reducing contaminant levels over time. Pump and treat is also used to control plume migration direction, groundwater flow direction and local groundwater elevations. Pump and treat is commonly used in conjunction with other technologies (e.g., soil vapor extraction, dual phase extraction using liquid ring pumps, etc.) as part of corrective action integrating multiple technologies toward achieving cleanup goals. The extracted vapors shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality.

Pump and treat is most effective in reducing high levels of contamination over time. As a long-term treatment option, pump and treat technology is associated with relatively costly operations and maintenance requirements; however, this option may be necessary to control plume migration or lower the local water table as necessary for other soil and groundwater remediation technologies.

A Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

This checklist is provided to help evaluate the appropriateness of the pump and treat technology to the remediation of the contamination at the site, to ensure the completeness of the CAP, and to expedite the review process. Submit the completed checklist with the CAP. Additional information may be required to determine if pump and treat will accomplish cleanup goals at this site, or a re-evaluation of alternative technologies may be required prior to submitting the CAP.

Complete the checklist below by answering the following questions and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

### Groundwater/Aquifer Characterization

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Have groundwater tests, such as slug tests, pumping tests, or other tests, been conducted to indicate whether pumping groundwater will produce the desired effect (e.g., drawdown, or effective extraction of contaminated water)? |

_____ ____ Have the results of aquifer tests been included in the CAP (e.g., hydraulic conductivity, groundwater flow velocities, and storativity)? Calculations and graphs resulting from any aquifer test conducted at the site shall be submitted in an appendix to the CAP.

_____ ____ Do aquifer parameters indicate that the impacted groundwater at this site is conducive to pump and treat technology?

**Groundwater Extraction System**

**Answer** **Page #**

_____ ____ Do groundwater analyses indicate that equipment fouling is likely to occur? If yes, a plan for the pretreatment of groundwater shall be proposed.

_____ ____ Does the CAP provide maps showing the location of all extraction wells and piping?

_____ ____ Does the CAP describe the criteria that were used to determine the location of extraction wells and piping, including existing on-site wells?

_____ ____ Does the CAP explain how the zones of influence for the extraction wells have been determined? (Provide calculations of zones of influence in an appendix.)

_____ ____ Does the CAP provide the expected influent concentrations? (Include any calculations in an appendix.)

_____ ____ How was the expected drawdown calculated for recovery wells? (Provide all calculations in an appendix.)

**Groundwater Treatment System**

***For Air Stripping***

**Answer** **Page #**

_____ ____ What, if any, air treatment systems are proposed for the site?

_____ ____ What is the estimated mass-transfer coefficient? (Provide all calculations in an appendix.)

_____ ____ Is the treatment to take place in a non-attainment zone?

_____ ____ Is a air effluent permit required and has the permit been applied for or granted?

***For Carbon/Other Material Adsorption***

**Answer** **Page #**

_____ ____ Does the CAP describe the adsorption systems?

_____ ____ Has a complete description of the adsorption process been included in the CAP?

_____ ____ Is pretreatment to be used on groundwater entering the adsorption unit?

_____ ____ Has a complete description of the pretreatment process been included in the CAP?

_____ ____ Does the CAP describe proposed system controls for the groundwater recovery and pretreatment and post-treatment systems?

_____ ____ Does the CAP include a plan for the disposal and replacement of spent carbon or other absorbent material?

***For Bioreactors***

**Answer** **Page #**

_____ ___ Does the CAP the describe the bioreactor system, including:
- estimated biomass specifications?
- estimated mass balance calculations for bioreactions?
- estimated necessary contact time?
(All calculations shall be included in an appendix.)

_____ ____ Is any pretreatment of groundwater entering the bioreactor necessary?

_____ ____ Does the CAP describe proposed system controls for the groundwater recovery and pretreatment and post-treatment systems?

_____ ____ Does the CAP describe system controls, such as recovery-well pump shutoff in case the bioreactor fails?

_____ ____ Does the CAP outline a plan for the disposal and replacement of the bioreactor?

**Discharge Permit Applications**

**Answer** **Page #**

_____ ____ Does the CAP propose a plan for obtaining and submitting applicable permits, including:

_____ ____ - KPDES or other surface water discharge permits?

_____ ____ - air emissions discharge permit?

_____ ____ - permit to dispose of contaminated carbon?

_____ ____ - disposal of bioreactor sludge?

_____ ____ - US EPA Underground Injection Control?

**Re-injection/Infiltration Galleries**

**Answer** **Page #**

_____ ____ Does the CAP propose that treated groundwater will be reintroduced to the subsurface as part of a flushing or bioremediation action? If so, the system is to be described in detail and any calculations included in an appendix.

_____ ____ Does the CAP indicate that the US EPA Region IV Office, Underground Injection Control (UIC) will be notified that construction of injection wells or infiltration

galleries is planned for this site? Generally, infiltration galleries do not require a permit; notification is sufficient.

**Operation and Monitoring Plans**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the CAP contain analyses of samples taken from each extraction well and each monitoring well within sixty (60) days of the date of submission of the CAP? |
| _____ | ____ | Does the CAP propose a schedule for monitoring site conditions at start-up and during system operation (minimally on a quarterly basis), including:<br>- water table contours?<br>- extent of free product present?<br>- rates of recovery from influent wells?<br>- water quality parameters (e.g., hardness, TSS, TDS, pH, temperature, etc.)? |
| _____ | ____ | Does the CAP propose a schedule for monitoring the progress of the corrective action system? |
| _____ | ____ | Does the CAP propose to submit monitoring reports on at least a quarterly basis? |
| _____ | ____ | Does CAP propose that sample analysis of all monitoring and extraction wells shall be submitted to the cabinet, minimally on a quarterly basis? |
| _____ | ____ | Does the CAP contain an alternative plan if system performance monitoring indicates that pump and treat technology will not attain cleanup levels below the maximum allowable levels for contaminants in groundwater at the site or is not effective in controlling migration of the contaminant plume? |

**Closure Plan**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the CAP Closure Plan provide for analyzing groundwater contaminant levels for a minimum of four (4) consecutive quarters after the system has been inactive? |
| _____ | ____ | Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory groundwater samples for no further action? |
| _____ | ____ | Does the CAP Closure Plan include collecting groundwater samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination in groundwater be sufficiently sampled to determine that contamination in the groundwater has been reduced to below the maximum allowable levels for the site.) |
| _____ | ____ | Does the CAP Closure Plan include sampling locations at a distance sufficient from extraction wells to examine the perimeter effectiveness of each extraction well? |

## Dual-Phase Extraction (DPE) CAP Checklist

### Overview

Dual-phase extraction, also known as multi-phase extraction or vacuum-enhanced extraction, is an in-situ technology that uses pumps to remove various combinations of contaminated groundwater, free product, and hydrocarbon vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal, or re-injected to the subsurface (where permissible). Dual-phase extraction systems can be effective in removing free product from the subsurface, thereby reducing concentrations of petroleum hydrocarbons in both the saturated and unsaturated zones of the subsurface. Dual-phase extraction systems are typically designed to maximize extraction rates; however, the technology also stimulates biodegradation of petroleum constituents in the unsaturated zone by increasing the supply of oxygen, in a manner similar to bioventing.

Vacuum groundwater extraction has been used for many decades as a standard method for extracting groundwater to control seepage or effect dewatering during construction and mining activities (Powers, 1981). Single-pump DPE systems represent a recent adaptation of this long-established technology to the task of subsurface remediation. Single-pump DPE systems are generally better suited to low-permeability conditions, and they are difficult to implement at sites where natural fluctuations in groundwater levels are substantial. United States patents exist on certain applications of single-pump DPE systems (Hess et al., 1991; Hajali et al., 1992; Hess et al., 1993).

The vacuum applied to the subsurface with DPE systems creates vapor-phase pressure gradients toward the vacuum well. These vapor-phase pressure gradients are also transmitted directly to the subsurface liquids present, and those liquids existing in a continuous phase (e.g., water and free product) will flow toward the vacuum well in response to the imposed gradients. The higher the applied vacuum, the larger the hydraulic gradients that can be achieved in both vapor and liquid phases, and thus the greater the vapor and liquid recovery rates.

### Site Characteristics

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Are the soil and aquifer media intrinsic permeabilities greater than $10^{-12}$ $cm^2$? |
| _____ | ____ | Is the soil free of impermeable layers of other conditions that would disrupt air flow? |
| _____ | ____ | Is the soil moisture in the unsaturated zone less than or equal to 85 percent of saturation? |
| _____ | ____ | Is depth to groundwater at least three feet? |

### Constituent Characteristics

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Are constituent vapor pressures greater than 0.5 mm Hg, boiling points less than 300°C, and Henry's Law constants greater than 100 atm? |
| _____ | ____ | Are the chemical sorptive capacities of the constituents present sufficiently low? |

**Evaluation of the DPE System Design**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the radius of influence (ROI) for the proposed extraction wells fall within the range of 5 to 100 feet? |
| _____ | ____ | Has the ROI been calculated for each soil type at the site? |
| _____ | ____ | For more complex sites with multiple treatment depth intervals and/or the need for multiple extraction wells, was subsurface airflow modeling conducted to determine well placement? |
| _____ | ____ | Is wellhead vacuum determined from field pilot studies and between 3 and 100 inches of water? |
| _____ | ____ | Is vapor extraction flow rate between 2 and 50 cfm per well? |
| _____ | ____ | Are groundwater extraction rates sufficient to capture groundwater with constituent concentrations above cleanup goals? |
| _____ | ____ | Will initial constituent vapor concentrations be monitored? |
| _____ | ____ | Are required final constituent concentrations specified? |
| _____ | ____ | Is a specified cleanup time required? |
| _____ | ____ | Is soil volume to be treated estimated? |
| _____ | ____ | Is the pore volume exchange rate calculated? |
| _____ | ____ | Are discharge limits specified? |
| _____ | ____ | Were site construction limitations considered? |
| _____ | ____ | Is the well density appropriate, given the total area to be cleaned up and the ROI of each well? |
| _____ | ____ | Is manifold piping design addressed and do extraction pipes slope toward the wells? |
| _____ | ____ | Is vapor pretreatment specified? |
| _____ | ____ | Is vapor treatment included, if warranted based on treatability study? |
| _____ | ____ | Is the blower selected appropriate for the desired vacuum conditions? |
| _____ | ____ | Are appropriate instrumentation and controls specified, including means to monitor pressure (or vacuum), air/vapor flow rate, groundwater extraction rates, carbon dioxide and/or oxygen concentrations in extracted air, and temperature? |

**Optional DPE Components**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Are land surface seals proposed? |

_____ ____ Are air injection or passive inlet wells proposed and are they appropriate to the site?

**Operation and Monitoring Plans**

**Answer** **Page #**

_____ ____ Does the CAP propose daily monitoring for at least 1 week of flow measurements, constituent concentrations, vacuum readings, and carbon dioxide and oxygen concentrations?

_____ ____ Does the CAP propose weekly to biweekly ongoing monitoring of these parameters?

**Closure Plan**

**Answer** **Page #**

_____ ____ Does the CAP Closure Plan provide for analyzing groundwater contaminant levels for a minimum of four (4) consecutive quarters after the system has been inactive?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory groundwater samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting groundwater samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination in groundwater be sufficiently sampled to determine that contamination in the groundwater has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include sampling locations at a distance sufficient from extraction wells to examine the perimeter effectiveness of each extraction well?

## Air Sparging CAP Checklist

### Overview

Air sparging is an *in situ* corrective action technology that reduces the concentration of volatile hydrocarbons that are adsorbed to soils and dissolved in groundwater. The technology, which is also known as "*in situ* air stripping" and "*in situ* volatilization," involves the injection of contamination-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved or adsorbed phase to a vapor phase. The air is then vented through the unsaturated zone. Air sparging is most often used with soil vapor extraction (SVE), but it can also be used with other corrective action technologies. When air sparging is combined with SVE, the SVE system creates a negative pressure in the unsaturated zone through a series of extraction wells to control the vapor plume migration. This combined system is called AS/SVE. If air sparging is to be used in conjunction with any other technologies, the checklists relevant to the other technologies used shall also be completed and included in the CAP. The extracted vapors shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality.

When used appropriately, air sparging has been found to be effective in reducing volatile organic compounds (VOCs) found in petroleum products at UST facilities. Air sparging is generally more applicable to lighter gasoline constituents (e.g., benzene, toluene, ethylbenzene, and xylenes [BTEX]), because they readily transfer from the dissolved phase to the gaseous phase. Air sparging is less applicable to diesel fuel, kerosene, and waste oil. Effective use of air sparging may require that it be combined with other corrective action methods (e.g., SVE, bioventing, pump and treat).

A Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

This checklist is provided to help evaluate the appropriateness of air to remediate the contamination at the site and the completeness of the CAP. Submit the completed checklist with the CAP. Additional information may be required to determine if air sparging will accomplish cleanup goals at the site, or a re-evaluation of alternative technologies may be required prior to submitting the CAP.

Answer the questions and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

### Factors That Contribute to the Vapor/Dissolved Phase Partitioning of the Constituents

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the Henry's law constant for each target chemical constituent? |
| _____ | ____ | What is the boiling point of each chemical target constituent? |
| _____ | ____ | What is the vapor pressure for each chemical target constituent? |

**Permeability of Soil**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the intrinsic soil permeability of impacted soils? |
| _____ | ____ | Is the soil permeability isotropic or anisotropic? |
| _____ | ____ | What is the dissolved iron concentration in groundwater? |

**Air Sparging System Design**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the radius of influence (ROI) for each of the proposed air sparging wells? |
| _____ | ____ | What is the ROI for each soil type at the site? (Submit any calculations in an appendix.) |
| _____ | ____ | Will the proposed extraction flow rates provide sufficient vapor/dissolved phase partitioning of contaminant constituents to achieve cleanup in the time allotted for remediation in the CAP? |
| _____ | ____ | Will the proposed air sparging pressure be sufficient to overcome the hydraulic head and capillary forces? |
| _____ | ____ | Will the proposed air-sparging pressure cause fumes to migrate into buildings, homes, etc.? |
| _____ | ____ | Are the number and placement of air sparging wells appropriate, given the total area to be cleaned up and the radius of influence of each well? |
| _____ | ____ | Are the proposed well-screen intervals sufficient to impact the contaminant plumes at the site? |
| _____ | ____ | Is the proposed well configuration appropriate for the site conditions present? |
| _____ | ____ | Have precautions been taken to prevent static buildup, static discharge, flashing, explosion, and fire? |

**Operation and Monitoring Plans**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the site presently have any free product or fume problems? |
| _____ | ____ | Does the CAP propose operating an SVE system prior to starting the air sparging system? |
| _____ | ____ | If the answer to the previous question is 'yes', is the SVE checklist included in the CAP? |
| _____ | ____ | Does the CAP contain a proposal to monitor system performance by measuring flow, vacuum readings, vapor concentrations, groundwater depth, dissolved oxygen levels, carbon dioxide levels, pH, or other constituents in extraction wells, monitoring wells, the manifold, and the effluent stack on a regular basis? |

_____ ____ Does the CAP contain a proposal for monitoring VOC vapors in nearby buildings and other nearby enclosed spaces?

_____ ____ Does the CAP contain a proposal for monitoring groundwater pH and levels of contaminants, carbon dioxide, and dissolved oxygen in groundwater on a regular basis following startup?

_____ ____ Does the CAP contain a proposal for monitoring effluent stack for levels of contaminants, oxygen, and carbon dioxide on a regular basis following startup?

_____ ____ Does the CAP contain a proposal to submit monitoring reports on at least a quarterly basis?

**Closure Plan**

**Answer Page #**

_____ ____ Does the CAP Closure Plan provide for analyzing groundwater contaminant levels for a minimum of four (4) consecutive quarters after the system has been inactive?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory groundwater samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting groundwater samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination in groundwater be sufficiently sampled to determine that contamination in the groundwater has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include sampling locations at a distance sufficient from sparge points to examine the perimeter effectiveness of each extraction well?

_____ ____ Does the CAP contain an alternative plan if system performance monitoring indicates that air sparging technology will not attain cleanup levels below the maximum allowable levels for contaminants in groundwater at the site or is not effective in controlling migration of the contaminant plume?

_____ ____ Does the CAP Closure Plan specify the methods for collecting and analyzing confirmatory groundwater samples for no further action?

**Thin-spreading of Petroleum-Contaminated Soils**
**CAP checklist**

**Overview**

Thin-spreading is a potential remediation as part or all of the corrective action at UST facilities with petroleum-contaminated soils. Thin-spreading, which is also known as "*ex situ* air stripping", "*ex situ* volatilization" and "*ex situ* biodegradation" involves the removal and relocation of contaminated soils to a treatment area. The soil is generally spread in thin layers and the contaminants are reduced through the processes of volatilization, hydrolysis, and biodegradation. Hydrocarbon-contaminated soils are commonly mixed with nutrients, microbes, and/or oxygen enhancers. Thin-spreading ideally maintains control of surface runoff, as well as seepage to the subsurface from the treatment area.

If petroleum-contaminated soils are to be treated at a permitted thin-spreading facility off-site, the CAP shall contain a copy of the approval letter from the Solid Waste Branch, 14 Reilly Road, Frankfort, Kentucky 40601, 502-564-6716. If contaminated soils are to be treated at a thin-spreading facility out of state, a receipt of disposal from the receiving facility shall be submitted to the cabinet within one hundred twenty (120) days of the acceptance of the CAP.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

Complete the checklist below, answering each question and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | Does the CAP propose to treat petroleum-contaminated soils by a thin spreading process? |
| _____ | ____ | Are petroleum-contaminated soils to be treated by thin-spreading at a permitted facility off-site? |
| _____ | ____ | If soils are to undergo thin-spreading at a facility off-site, what is the permit number for the facility? |
| _____ | ____ | Is the proposed treatment to occur in a non-attainment zone? |
| _____ | ____ | Is an air emissions permit required for the proposed remediation as determined by the Division of Air Quality, and is the permit in the CAP? |
| _____ | ____ | Are all other required or applicable checklists complete and included in the CAP? |

## Low Temperature Thermal Desorption (LTTD) CAP Checklist

### Overview

Low-Temperature Thermal Desorption (LTTD), also know as low-temperature thermal volatilization, thermal stripping, and soil roasting, is an ex-situ corrective action technology that uses heat to physically separate petroleum hydrocarbons from excavated soils. Thermal desorbers are designed to heat soils to temperatures sufficient to cause constituents to volatilize and desorb (physically separate) from the soil. Although they are not designed to decompose organic constituents, thermal desorbers can, depending upon the specific organics present and the temperature of the desorber system, cause some of the constituents to completely or partially decompose. The vaporized hydrocarbons are generally treated in a secondary treatment unit (e.g., an afterburner, catalytic oxidation chamber, condenser, or carbon adsorption unit) prior to discharge to the atmosphere. Afterburners and oxidizers destroy organic constituents. Condensers and carbon adsorption units trap organic compounds for subsequent treatment or disposal. The extracted vapors shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality.

Some pre- and post-processing of soils is necessary when using LTTD. Excavated soils are first screened to remove large (> 2 inches in diameter) objects. These may be sized (e.g., crushed or shredded) and then introduced back into the feed material. After leaving the desorber soils are cooled, re-moistened to control dust, and stabilized (if necessary) to prepare them for disposal/reuse. Treated soil may be redeposited at the site, used as cover in landfills, or incorporated into asphalt.

Thermal desorption systems fall into two general classes -- stationary facilities and mobile units. Contaminated soils are excavated and transported to stationary facilities; mobile units can be operated directly on-site. Desorption units are available in a variety of process configurations including rotary desorber, asphalt plant aggregate dryers, thermal screws, and conveyor furnaces.

LTTD has proven very effective in reducing concentration of petroleum contamination in soils, including gasoline, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils. LTTD is applicable to constituents that are volatile at temperatures as great as 1200°F.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

Answer the following questions and insert the page number(s) of the CAP where the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

**Evaluation of LTTD Effectiveness**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the plasticity of the soils to be treated? |
| _____ | ____ | What is the maximum diameter of soil particles to be treated? |
| _____ | ____ | What is the soil moisture content? |
| _____ | _____ | What is the total petroleum hydrocarbon concentration by weight in the soils to be treated? |
| _____ | _____ | Is the volatility of the hydrocarbons present in soil and groundwater relatively low? |

**Determination if soils require pretreatment.**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the concentration of humic material in the soils to be treated? |
| _____ | ____ | What is the concentration of heavy metals (e.g., Pb, Cr) in the soils to be treated? |
| _____ | ____ | What are $K_{ow}$'s for the target chemical constituents? |
| _____ | ____ | Are dioxin precursors present in the soils? |

(It may be necessary that a pilot test or "test burn" be conducted to demonstrate that LTTD is an applicable corrective action technology.)

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Do the results of the pilot test indicate that LTTD is applicable? |

**Evaluation of the Practicality of Using LTTD**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the maximum depth to which the contaminated soils extend? |
| _____ | ____ | Is the contaminated soil contained within the site boundaries? |
| _____ | ____ | Is there contamination beneath buildings or near building foundations? |
| _____ | ____ | Is excavation of the soil practical and cost-efficient to LTTD? |
| _____ | ____ | Is sufficient land area available for operation of equipment and temporary storage (staging) of contaminated soil and treated soil to be treated on-site? |
| _____ | ____ | What is the distance to an off-site facility? |
| _____ | ____ | Does surrounding land use permit operation of an on-site system? |

**Evaluation of the Effectiveness of Using LTTD**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Have an adequate number of in-situ soil samples been collected and analyzed in order to delineate the extent of contamination? |
| _____ | ____ | At what frequency are treated soil samples to be collected and analyzed? |
| _____ | ____ | Has the proposed desorption unit successfully treated soils with similar contaminant concentration levels? |
| _____ | ____ | What is the ultimate disposal location of the soil (e.g., return to excavation, transport to landfill for cover) proposed in the CAP? |

**Permitting, Monitoring, and Final Closure Report Requirements**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Has the Division for Air Quality been contacted to determine the current requirements for air emissions? |
| _____ | ____ | Does the CAP contain a copy of the permit or acceptance letter from the Division for Air Quality or a letter indicating that no permit is required? |
| _____ | ____ | Is a vapor treatment process proposed to treat emissions from the LTTD process? |
| _____ | ____ | Does the CAP include a proposed sampling plan of excavated soil prior to and following treatment, using the appropriate SW-846 sampling and analysis protocols? |
| _____ | ____ | Does the CAP contain a plan for the proper storage and transport for the excavated material before, during, and after treatment is included? |
| _____ | ____ | Does the CAP contain a Closure Plan for the excavation(s), outlining sampling locations and protocols, and the methods of analysis? |
| _____ | ____ | Does the CAP include a proposal for sampling and analysis of any water encountered during excavation activities? |

## Innovative Corrective Action Technologies CAP Checklist

### Overview

This checklist shall be used for any technology for which a specific checklist is not provided in this outline. A thorough overview of the nature, processes, and status of any innovative technology proposed to be utilized at a site undergoing corrective action, whether as the sole technology, or in tandem, or in conjunction with any other remediation technology, shall be presented in the CAP. This discussion shall include: a summary of the application of the technology to the conditions at the site; a thorough presentation of the equipment and processes to be utilized; and how the system performance is to be monitored. In addition, a plan shall be submitted outlining the requirements of the CAP for monitoring the fate and transport of contaminants at the site during remediation. Also, a Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used. The cabinet reserves the right to withhold approval of an innovative corrective action technology if sufficient information has not been presented to determine the appropriateness of the technology in relation to the site.

Should the proposed technology generate vapors, extracted gases shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

Answer the questions below and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

### System Design

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the CAP include a thorough overview of the proposed corrective action technology? |
| _____ | ____ | Does the CAP include a discussion of the applicability of the technology to the conditions at the site? |
| _____ | ____ | Does the CAP include a discussion of the application of the proposed technology to the treatability of the contamination at the site? |
| _____ | ____ | Does the CAP include the results of any pilot studies conducted regarding the application of the proposed technology at the site? |

### Monitoring Plan

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Does the CAP include a plan for the start-up and performance of the system? |

_____ ____ Does the CAP include a plan for monitoring the levels and location of contaminants at the site during the remediation? (Monitoring reports shall be submitted minimally on a quarterly basis.)

**Closure Plan**

**Answer** **Page #**

_____ ____ Does the CAP include a plan outlining a time-table for remediation, which includes no further action sampling protocols and analytical methods to be used?

_____ ____ Does the CAP Closure Plan provide for analyzing groundwater contaminant levels for a minimum of four (4) consecutive quarters after the system has been shut down?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory groundwater samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting groundwater samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination in groundwater be sufficiently sampled to determine that contamination in the groundwater has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include sampling locations at a distance sufficient from treatment points to examine the perimeter effectiveness of each extraction well?

_____ ____ Does the CAP contain an alternative plan if system performance monitoring indicates that the proposed technology will not attain cleanup levels below the maximum allowable levels for contaminants in groundwater at the site or is not effective in controlling migration of the contaminant plume?

_____ ____ Does the CAP Closure Plan specify the methods for collecting and analyzing confirmatory groundwater samples for no further action for four (4) consecutive quarters after the system has been inactive?

## Bioventing CAP Checklist

### Overview

Bioventing is an in-situ remediation technology that uses indigenous microorganisms to biodegrade organic constituents adsorbed to soils in the unsaturated zone. Soils in the capillary fringe and the saturated zone are not affected. In bioventing, the activity of the indigenous bacteria is enhanced by inducing air (oxygen) flow into the unsaturated zone (using extraction and/or injection wells) and, if necessary, by adding nutrients.

When extraction wells are used for bioventing, the process is similar to soil vapor extraction (SVE). However, while SVE removes constituents primarily through volatilization, bioventing systems promote biodegradation of constituents and minimize volatilization (generally by using lower air flow rates than for SVE). In practice, some degree of volatilization and biodegradation occurs when either SVE or bioventing is used.

All aerobically biodegradable constituents can be treated by bioventing. In particular, bioventing has proven to be very effective in remediating UST system releases of petroleum products including gasoline, jet fuels, kerosene, and diesel fuel. Bioventing is most often used to address mid-weight petroleum products (e.g., diesel fuel and jet fuel) because lighter products (e.g., gasoline) tend to volatilize readily and can be removed more rapidly using SVE. Heavier products (e.g., lubricating oils) generally take longer to biodegrade than the lighter products.

Should the bioventing system generate vapors, extracted gases shall be treated if the off-gas discharge is located within 300 meters of a residential area or other sensitive receptors (schools, day care centers, hospitals, etc.) or as required by the Division for Air Quality.

A Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

Answer the questions below and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

### Site Characteristics

| Answer | Page # | |
|---|---|---|
| _____ | ____ | What is the intrinsic permeability of the soil? |
| _____ | ____ | Is the soil free of impermeable layers or other conditions that would disrupt air flow? |
| _____ | ____ | What is the heterotrophic bacteria count in dry soil? |
| _____ | ____ | What is the soil pH? |
| _____ | ____ | What is the moisture content of the soil in contaminated zones? |

_____ ____ What is soil temperature during the proposed treatment season?

_____ ____ What is the intrinsic, or augmented carbon:nitrogen:phosphorus ratio?

_____ ____ What is the depth to groundwater?

**Constituent Characteristics**

**Answer** **Page #**

_____ ____ Are all of the target chemical constituents sufficiently biodegradable?

_____ ____ What is the approximate concentration of Total Petroleum Hydrocarbons in the soils (in ppm)?

_____ ____ If there are constituents with vapor pressures greater than 0.5 mm Hg, boring ranges above 300°C, or Henry's Law constants greater than 100 atm/mole fraction, has the CAP addressed the potential environmental impact of the volatilized constituents?

**Evaluation of the Bioventing System Design**

**Answer** **Page #**

_____ ____ What is the radius of influence (ROI) for the proposed extraction or injection wells?

_____ ____ What is the calculated ROI for each soil type at the site? (Include all calculations in an appendix of the CAP.)

_____ ____ What types of wells (horizontal or vertical) are proposed for the site conditions?

_____ ____ What is the well spacing relative to the calculated ROI of the soils?

_____ ____ At what depths are the proposed well screen intervals?

_____ ____ Are air injection wells proposed?

_____ ____ What type of air injection well is proposed?

_____ ____ Are the proposed air injection rates sufficiently low to prevent migration of the plume?

**Optional Bioventing Components**

**Answer** **Page #**

_____ ____ Is nutrient delivery proposed?

_____ ____ Is nutrient addition (if necessary) proposed to be controlled on a periodic or a continuous basis?

_____ ____ Are surface seals proposed?

_____ ____ Are the proposed sealing materials appropriate for the site?

_____ ____ Will groundwater depression be necessary?

_____ ____ If groundwater depression is necessary, are the pumping wells correctly spaced relative to their ROI? (Include all calculations in an appendix to the CAP.)

_____ ____ Is a vapor treatment system required?

_____ ____ If a vapor treatment system is required, is the proposed system appropriate for the contaminant concentration at the site?

_____ ____ Does the CAP include a copy of any required permits, letters of approval for any air or water emissions resulting from remediation at the site? If no permit is required, a letter indicating such shall be submitted with the CAP.

**Operation and Monitoring Plan**

**Answer Page #**

_____ ____ Does the system performance monitoring plan propose monitoring of emission of VOC's and carbon dioxide concentration?

_____ ____ Is subsurface soil sampling proposed for tracking constituent reduction and biodegradation conditions?

_____ ____ Does the CAP contain a proposal to submit monitoring reports, at a minimum, on a quarterly basis?

**Closure Plan**

**Answer Page #**

_____ ____ Does the CAP include a plan outlining a time-table for remediation, which includes no further action sampling protocols and analytical methods to be used?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory soil samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting soil samples in those areas previously shown to be contaminated? (Meaning that the previously demonstrated horizontal and vertical extent of contamination shall be sufficiently sampled to determine that contamination in the soils has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include sampling locations at a distance sufficient from extraction wells to examine the perimeter effectiveness of each extraction well?

## Site-Specific Risk Assessment CAP Checklist

**Overview**

Risk assessment may be conducted as an option to corrective action at an site to determine whether the contaminant levels to remain at a site present an unacceptable risk to human health and the environment.

Site-specific risk assessment is reviewed by the Division of Environmental Services, 502-564-6120. Risk Assessment proposals for UST facilities shall be submitted to the UST Branch, and these proposals will be referred to the Division of Environmental Services for review. The UST Branch will notify the owner/operator of the findings of the Division of Environmental Services.

Answer the questions below and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information. If site-specific risk assessment is to be used in tandem with any other technology, the checklists relevant to the other proposed remediation technologies shall be completed and included in the CAP.

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | Has the UST Branch been contacted in order to receive a complete copy of the appropriate documents pertaining to Risk Assessment? |
| _____ | ____ | Has the Risk Assessment proposed been approved by the Division of Environmental Services? |
| _____ | ____ | Have all other applicable CAP checklists been completed and included in the CAP? |

## Residual Landfill CAP Checklist

**Overview**

Residual landfill status includes leaving contamination in place. The levels of contamination allowed to be left in place remain above the levels required for no further action under the Underground Storage Tank regulations. Residual landfills are regulated by the Division of Waste Management. The application requirements for residual landfills are found in 401 KAR Chapters 47 and 48. The technical requirements for residual landfills are included in 401 KAR 48:050 and 401 KAR 48:170. Residual landfills require a landfill CAP and involve monitoring at the site. If part of the CAP is to eventually close the site as a residual landfill, a residual landfill permit shall be obtained from the Division of Waste Management. In order to obtain a residual landfill permit contact:

Solid Waste Branch
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort KY 40601
502-564-6716

Answer the questions below and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

**Check the appropriate box.**

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | Has the Solid Waste Branch been contacted to determine the current permit requirements for residual landfills? |
| _____ | ____ | Is a copy of the residual landfill permit application submitted to the Solid Waste Branch enclosed? |
| _____ | ____ | Is a copy of the residual landfill permit issued by the Solid Waste Branch enclosed? |

## Enhanced Bioremediation as an Option for Corrective Action

### Overview

Biodegradation means degradation of organic compounds, in soil or groundwater, by indigenous or introduced microbes. Enhanced Bioremediation is an application of biodegradation of organic compounds by microbes as a remediation when natural conditions have been altered to augment biodegradation at the site. Enhanced bioremediation may be a suitable corrective action where the contaminants of concern are readily biodegradable, site conditions are favorable, and the time necessary for bioremediation to achieve cleanup levels in soils and groundwater is reasonable. However, limiting factors such as insufficient nutrients, depleted oxygen levels, or insufficient time exist at the site. Therefore microbial populations and microbial activity may require enhancement by the introduction of nutrients (e.g., nitrogen, phosphate), oxygen, other microbes, etc., in order to reduce contaminant levels in the amount of time considered acceptable for this corrective action, and/or to control plume migration. If artificial enhancement of microbial populations, nutrients, soils gases, etc. are required, this is known as "enhanced" bioremediation.

Site conditions may indicate that biodegradation of the contaminants present at the site will be sufficient to reduce contaminant levels and/or control plume migration without artificial enhancement; this is known as "naturally occurring" or "intrinsic" bioremediation. If intrinsic bioremediation is the only corrective action method to be used at the site, the Monitoring Only CAP Checklist shall be used.

Application of enhanced bioremediation as a remediation technology requires that the site be evaluated to ensure that the site conditions are appropriate for the technology being proposed, that the technology proposed will not create resultant adverse conditions in the soil, air, or water, and that a sufficient monitoring plan be developed. Bioremediation can be a long-term remediation option; requiring years or decades to effect adequate cleanup of a site. Numerous factors affect the potential for and rate of bioremediation at a given site, such as:

* soil moisture content
* porosity
* soil temperature
* soil pH
* $O_2$ availability
* production of degradation products (e.g., MEK)
* presence of suitable microbes
* contaminants present and their concentrations
* availability of nutrients
* presence of other electron receptors
* redox potential (Eh)

Because of the dependence on these factors, adequate site characterization is essential for determining the viability of bioremediation as an option for all, or part of, the corrective action at a given site. The characterization of a site for evaluation of bioremediation potential shall be part of the initial site investigation and involves:

* characterization of the contaminants at a site;
* assessment of physicochemical conditions at the site and the presence of appropriate nutrients; and
* in some cases, assessment of microbiological parameters to determine the presence and viability of an appropriate microbial population may be necessary.

Characterization of site heterogeneity (e.g., anisotropic groundwater flow patterns, anisotropic soil permeability, etc.) and the potential for the further migration of contaminants shall be included in the site investigation. The number of samples necessary to adequately characterize a site for bioremediation will vary based on the extent of contamination and the heterogeneity of the distribution of contamination at the site, and the heterogeneity of the soils and groundwater flow at the site.

**Contaminant Characterization**

**Contaminants Present and Their Concentrations**

It is important to identify the contaminants at a site, determine whether there is a potential for further migration of the contaminant plume, and determine whether the contaminants are readily amenable to bioremediation.

Degradation of most volatile compounds is inhibited whenever organic vapors are present in high concentrations in the soils and/or groundwater. Inhibited biodegradation may be due to either acute toxic effects and/or reduced oxygen levels. Acute toxicity to microorganisms is unlikely if residual levels of volatile organic compounds are less than several hundred mg/kg.

**Biodegradability**

Most petroleum hydrocarbons are readily biodegradable through aerobic metabolism. Many are also biodegraded by anaerobic metabolism, though at lower rates. In general the following are true:

* Water-soluble compounds are usually degraded faster than less soluble compounds;
* The n-alkanes, n-alkylaromatics, and aromatic compounds in the $C_5$ to $C_{22}$ range are usually readily biodegradable. These compound comprise a major portion of gasoline and diesel fuel;
* The n-alkanes, n-alkylaromatics, and aromatic compounds above $C_{22}$ have very low water solubilities, which result in slower biodegradation rates. These compounds are found in heavier oils;
* Condensed or fused aromatic and cycloparaffinic compounds with four or more rings have very low biodegradation rates. These include most of the PAH compounds; and
* The rate of oxidation of straight-chain aliphatic hydrocarbons is inversely proportional to hydrocarbon chain length.

**Environmental Parameters**

Characterization of environmental parameters at a site is necessary to determine whether the physical and chemical conditions at the site are amenable to bioremediation, or whether conditions at the site need to be altered by introduced methods. The specific parameters that need to be evaluated for a given site shall be determined on a site-specific basis. These parameters may include the following:

* soil moisture content
* soil moisture holding capacity/ field capacity
* soil porosity
* intrinsic soil permeability
* bulk density of soil
* soil pH
* soil water dissolved oxygen
* soil gas oxygen content
* storativity of impacted aquifer(s)
* groundwater temperature
* groundwater flow rate and direction
* hydraulic conductivity of impacted aquifer(s)
* porosity and permeability of impacted aquifers
* aquifer isotropy/anisotropy
* specific yield/specific retention of impacted aquifers
* organic matter content (OM)
* total organic carbon (TOC)
* total organic nitrogen (TON)
* soil redox potential (Eh)
* inorganic nitrogen (as $NH_3$, $NO_2$, $NO_3$)
* soluble phosphorus (*o*-$PO_4$)
* soluble manganese ($Mn^{2+}$)
* iron ($Fe^{2+}$, $Fe^{3+}$)
* sulfate ($SO_4^{2-}$)
* plume migration rate and direction
* hydraulic gradient
* groundwater dissolved oxygen
* groundwater Eh
* groundwater Ph
* homogeneity/heterogeneity of groundwater flow
* availability of nutrients

**Microbiological Characterization**

Assessing the presence of suitable microbes for degrading specific organic contaminants at a site is critical for implementation of bioremediation as a corrective action. Petroleum hydrocarbon-degrading microbes are widespread in the subsurface; in most cases they can be assumed to be present. However, some site conditions, such as marginal environmental conditions or high concentrations of contaminants or organic vapors, make it necessary to determine whether a viable microbial population is present. Based on the results of enumeration studies it may be determined that bioremediation is unsuitable at the site or that the microbe populations need to be enhanced by other methods.

**Enumeration Studies**

Microbial enumeration studies and column studies employ plate counts to determine relative numbers of total aerobic heterotrophs and total hydrocarbon degraders as qualitative measures for "clean" versus "contaminated" areas. These laboratory studies can provide evidence that the necessary microorganisms are present at a site and that metabolic adaptation has occurred. However, it is difficult to directly relate these studies to biodegradation potential, as laboratory conditions do not replicate site conditions. Enumeration studies are probably most useful for comparison of the areas of highest contamination, where aerobic microbial populations may be significantly reduced, to uncontaminated areas.

**Respirometry**

Respirometry is an indirect method for determining the presence of a viable microbial community at a site, and provides an indication whether *in situ* biodegradation is occurring at the site. Soil respirometry measures $O_2$ depletion/$CO_2$ production in the soil and can provide a measure of biological activity when compared with background measurements outside the zone of contamination at the site. Increased $O_2$ depletion/$CO_2$ production in the contaminated area relative to the background ratios indicates that aerobic biodegradation is occurring.

**Monitoring Requirements**

If the results of the site characterization indicate that bioremediation is appropriate to the site conditions and enhanced bioremediation is proposed as a corrective action, a monitoring plan shall be developed and implemented in order to evaluate the progress and effectiveness of bioremediation at the site. Monitoring shall serve several purposes:

* to sufficiently monitor the entire extent of contamination;
* to provide an indication that contaminant concentrations are decreasing over time;
* to insure that the decrease in contaminant concentration is due to degradation, or other corrective action processes ongoing at the site, and not due to contaminant migration or dilution;
* to provide information regarding degradation rates; and
* to provide data regarding the nature of biodegradation at the site.

From the standpoint of evaluating remediation effectiveness, the monitoring need not distinguish between biodegradation and abiotic degradation or loss of contaminants (such as volatilization, etc.) resulting from natural processes or other corrective action efforts ongoing at the site (such as air sparging, soil vapor extraction, etc.).

**Monitoring Plan**

A variety of approaches and techniques are available for monitoring biodegradation and there is no set standard. A variety of approaches and/or techniques may be appropriate, especially if other remediation efforts are being used in conjunction with bioremediation. The monitoring plan shall be developed to address the nature of the contaminants and the physical conditions at the site. Monitoring shall be conducted to ensure that any measured loss of contaminants is not due to migration or dilution.

The monitoring plan shall include at a minimum:

* a description of the monitoring approaches and techniques to be used;
* a description of the sampling plan (on a minimally quarterly basis);
* establish benchmarks to monitor the progress of remediation;
* the analytes to be sampled; and
* the analytical methods to be used.

**Monitoring Approaches**

**Change in concentrations of original contaminants**

Confirmatory sample analysis for the target contaminants can be completed using the appropriate SW-846 methods. Soil and water samples may be taken from temporary constructions such as bore holes or direct-push methods. Water samples can be taken from permanent monitoring wells constructed at the site. The sampling shall monitor previously uncontaminated zones (both below and beyond the plume) to ensure that decreases in contaminants have not been due to plume migration.

**Change in concentration of co-reactants**

Changes in the concentration of various nutrients ($PO_4$, $NH_4$, $NO_2/NO_3$), electron receptors ($O_2$, $NO_3$, $Fe^{3+,2+}$, $Mn^{4+,3+,2+}$, $SO_4$), and reaction by-products ($CO_2$, $CH_4$, $N_2$) can potentially provide information on the type and progress of biodegradation. These changes shall be compared to those in equivalent samples from outside the area of contamination to provide control.

Changes in physical and physicochemical properties, appropriate to the media being sampled, can be measured as well. These may include soil moisture content, soil/groundwater Ph, redox potentials, and temperature. Changes in these parameters can provide information for interpreting the other monitoring results.

All groundwater monitoring wells shall be analyzed minimally on a quarterly basis for the target contaminants, beginning within 120 days of receipt of a letter indicating that the CAP is acceptable.

**Final Closure Requirements**

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants (using the appropriate SW-846 methods) in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080, and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of the contaminant plume(s) and/or the production of degradation products.

**Enhanced Bioremediation CAP Checklist**

This checklist is provided to help evaluate the appropriateness of the enhance bioremediation to the remediation of the contamination at the site and the completeness of the CAP. Submit the completed checklist with the CAP. Additional information may be required to determine how enhanced bioremediation will accomplish cleanup goals at this site, or a re-evaluation of alternative technologies is required prior to submitting the CAP.

Answer the questions below and insert the page number(s) of the CAP on which the relevant information is included. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

**Contaminant Characterization**

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | Are the contaminants present at the site likely to migrate off-site? |
| _____ | ____ | Has all free product been recovered? |
| _____ | ____ | What are the petroleum hydrocarbon contaminant concentrations in the soils at the site? |
| _____ | ____ | What are the petroleum hydrocarbon contaminant concentrations in the groundwater at the site? |
| _____ | ____ | At what concentrations are organic vapors present in the soils at the site? |
| _____ | ____ | Are the target chemical constituents present at the site predominantly water-soluble? |
| _____ | ____ | Are the target chemical constituents present predominantly n-alkanes, n-alkylaromatics, and aromatic compounds in the $C_5$ to $C_{22}$ range? |

**Environmental Parameters**

| **Answer** | **Page #** | |
|---|---|---|
| _____ | ____ | What is the soil moisture content at the site as a percentage of the field capacity? |
| _____ | ____ | What is the air-filled pore space of soils at the site? |
| _____ | ____ | What is the saturated hydraulic conductivity for unsaturated zone soils (in cm/sec)? |
| _____ | ____ | What are the water-holding capacities of the soils at the site? |
| _____ | ____ | What is the range of soil temperatures at the site? |
| _____ | ____ | What is the range of groundwater temperatures at the site? |
| _____ | ____ | What is the range in intrinsic pH of the soils at the site? |
| _____ | ____ | What is the range in intrinsic pH of the groundwater at the site? |

_____ ____ What are the dissolved oxygen levels in contaminated groundwater at the site?

_____ ____ What is the redox potential, *Eh*, for the soils at the site?

_____ ____ What is the redox potential, *Eh*, for impacted groundwater at the site?

_____ ____ What is the total organic nitrogen content of soils at the site?

_____ ____ What is total organic nitrogen content of impacted groundwater at the site?

_____ ____ What is the carbon:nitrogen:phosphate ratio in the soils at the site?

_____ ____ Are other nutrients (e.g., K, Ca, Mg, S) found in adequate supply for metabolic needs in the soils and/or groundwater at the site?

_____ ____ If soil/groundwater oxygen levels are low, are other terminal electron acceptors present in the soil/groundwater that may be used for microbial metabolism?

_____ ____ What is the hydraulic conductivity of the contaminated groundwater at the site?

_____ ____ Has the groundwater flow rate and direction been determined?

_____ ____ Has the contaminant plume migration/dispersion rate and direction been determined?

_____ ____ Have all other relevant groundwater/aquifer parameters been determined in order that proper application and monitoring of enhanced bioremediation may occur?

**Microbial Characterization**

**Answer** **Page #**

_____ ____ Has a viable microbial community been demonstrated in the soils/groundwater at the site either by enumeration studies, column studies, or respirometry?

_____ ____ Does the CAP include the results of enumeration studies or column studies conducted to determine the distribution of total aerobic heterotrophs and total hydrocarbon degraders in the soil/groundwater at the site?

_____ ____ Does the CAP include the results of any respirometry studies conducted to monitor microbial activity at the site?

**Enhancement Plan**

**Answer** **Page #**

_____ ____ Is biostimulation proposed to be used?

_____ ____ What biostimulation technique is to be used?

_____ ____ What is the source for $O_2$?

_____ ____ What is the range of $O_2$?

_____ ____ What is the source and supplier of other nutrients?

_____ ____ What is the electron receptor?

_____ ____ What were the initial ranges of nitrogen and phosphorous?

_____ ____ What are the target ranges for nitrogen and phosphorous?

_____ ____ Is the stoichiometric calculation of $O_2$ demand included in the CAP?

_____ ____ Is bioaugmentation proposed to be used?

_____ ____ Do microbial population studies substantiate the need for bioaugmentation?

_____ ____ What is the source and supply of nutrients to be used?

_____ ____ What is the initial nitrogen:phosphorous ratio?

_____ ____ What is the target nitrogen:phosphorous ratio?

_____ ____ Does the plan for enhancing site conditions satisfy inadequate conditions noted in the site characterization or in the checklists above?

_____ ____ Does the plan for enhancing site conditions present a potential for causing migration of the plume beyond established acceptable boundaries?

_____ ____ Does the plan for enhancing site conditions present a potential for reducing concentrations of original contaminants by dilution?

**Monitoring Plan**

**Answer Page #**

_____ ____ Does the CAP propose to monitor nitrogen residuals?

_____ ____ Does the CAP propose to monitor potential migration of the plume beyond acceptable boundaries?

_____ ____ Does the CAP monitoring plan include a description of the monitoring approaches to be used?

_____ ____ Does the CAP monitoring plan include a description of the sampling plan? Sampling is to be conducted minimally, on a quarterly basis?

_____ ____ Does the CAP monitoring plan include a list of the analytes to be sampled?

_____ ____ Does the CAP monitoring plan include the sampling and analytical methods to be used?

_____ ____ Will the CAP monitoring plan provide an indication that contamination is decreasing over time?

_____ ____ Can the CAP monitoring plan isolate any decrease in concentration due to degradation and not migration of the contaminants?

_____ ____ Does the CAP monitoring plan provide information regarding degradation rates?

_____ ____ Does the CAP monitoring plan provide information regarding the nature of degradation at the site?

_____ ____ Does the CAP monitoring plan include monitoring changes in concentration of original contaminants?

_____ ____ Does the CAP monitoring plan include monitoring changes in concentration of co-reactants such as various nutrients ($PO_4$, $NH_4$, $NO_2/NO_3$), electron acceptors ($O_2$, $NO_3$, $Fe^{3+,2+}$,$Mn^{4+,3+,2+}$,$SO_4$), and reaction by-products ($CO_2$, $CH_4$, $N_2$)?

_____ ____ Does the CAP contain an alternative plan if system performance monitoring indicates that enhanced bioremediation will not attain cleanup levels below the maximum allowable levels for contaminants in groundwater at the site or is not effective in controlling migration of the contaminant plume?

**Closure Plan**

**Answer** **Page #**

_____ ____ Does the CAP Closure Plan provide for analyzing groundwater contaminant levels?

_____ ____ Does the CAP Closure Plan specify the methods for collecting and analyzing confirmatory groundwater samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting groundwater samples in those areas previously shown to be contaminated? (The previously demonstrated horizontal and vertical extent of contamination in groundwater be sufficiently sampled to determine that contamination in the groundwater has been reduced to below the maximum allowable levels for the site.) Does the CAP Closure Plan provide for analyzing groundwater contaminant levels for a minimum of four (4) consecutive quarters after application of enhanced bioremediation?

_____ ____ Does the CAP Closure Plan outline the methods for collecting and analyzing confirmatory soil samples for no further action?

_____ ____ Does the CAP Closure Plan include collecting soil samples in those areas previously shown to be contaminated? (The previously demonstrated horizontal and vertical extent of contamination shall be sufficiently sampled to determine that contamination in the soils has been reduced to below the maximum allowable levels for the site.)

_____ ____ Does the CAP Closure Plan include collecting soil and groundwater samples in those areas previously shown not to be contaminated? (Soil and groundwater on the perimeter of the previously demonstrated horizontal and vertical extent of contamination shall be sufficiently sampled to determine that reductions in contaminant concentration in the soil and groundwater have not resulted from migration.)

## Monitored Natural Attenuation (MNA) Checklist

### Overview

The term “monitored natural attenuation” (MNA) refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. Long-term performance monitoring is a fundamental component of a MNA remedy, hence the emphasis on “monitoring” in the term “monitored natural attenuation.” Other terms associated with natural attenuation in the literature include “intrinsic remediation”, “intrinsic bioremediation”, “passive bioremediation”, “natural recovery”, and “natural assimilation.” Note, however, that none of these are necessarily equivalent to MNA.

MNA is often dubbed “passive” remediation because natural attenuation processes occur without human intervention to a varying degree. It should be understood, however, that this does not imply that these processes necessarily will be effective in meeting remediation objective within a reasonable time frame.

The fact that some natural attenuation processes are occurring does not preclude the use of “active” remediation or the application of enhancers of biological activity (e.g., electron acceptors, nutrients, and electron donors). In fact, MNA will typically be used in conjunction with, or as a follow–up to, active remediation measure, and typically only after source control measures have been implemented.

A Closure Plan shall be submitted in the CAP outlining a time-table for the corrective action and no further action sampling protocols, including the analytical methods to be used. The cabinet reserves the right to withhold approval of MNA if sufficient information has not been presented to determine its appropriateness in relation to the site.

The final closure request in the last monitoring report shall consist of sampling soil and groundwater and analyzing for the target contaminants in a manner sufficient to ensure that all previously contaminated soils and groundwater are below the maximum allowable contaminant concentration levels established for this site in accordance with 401 KAR 42:080 and that any potentially impacted soils and/or groundwater have been sufficiently sampled to ensure that no secondary contamination has occurred due to migration of contamination and/or the production of degradation products.

Answer the appropriate questions on the MNA checklists and include the checklist(s) in the CAP. If the relevant information is not included in the CAP, the CAP shall be amended to include the necessary relevant information.

**Initial Screening – Soil Contamination ONLY**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Has source mass been estimated? |
| _____ | ____ | Is the source mass likely to remain trapped within the soil? |
| _____ | ____ | Has source longevity been estimated? |
| _____ | ____ | Is the estimate of the length of time required to meet remediation objectives reasonable? |
| _____ | ____ | Is there a threat of potential receptors coming in contact with contaminated soil? |
| _____ | ____ | Is there a threat to potential receptors from vapor migration? |

**Initial Screening – Groundwater Contamination**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Has free product (if present initially) been recovered to the maximum extent practicable? |
| _____ | ____ | Has source mass been estimated? |
| _____ | ____ | Has the plume lifespan been estimated? |
| _____ | ____ | Is the estimate of the length of time required to meet remediation objectives reasonable? |
| _____ | ____ | Based on the evaluation of field data, is the plume shrinking? |
| _____ | ____ | Are all potential receptors located at a distance represented by a minimum 2-year travel time? |

**Detailed Evaluation – Soil Contamination**

| Answer | Page # | |
|---|---|---|
| _____ | ____ | Has comprehensive, 3-dimensional site characterization been completed? |
| _____ | ____ | Has soil permeability been measured? |
| _____ | ____ | Is soil structure and layering conducive to natural attenuation processes? |
| _____ | ____ | Has soil organic carbon content ($f_{oc}$) been measured? |
| _____ | ____ | Have soil saturation limits been calculated for all contaminants of concern? |
| _____ | ____ | Are all soil saturation limits for all contaminants of concern below levels expected to cause unacceptable groundwater impacts? |
| _____ | ____ | Have soil gas samples been collected and analyzed? |

_____ ____ Have soil geochemical parameters been measured and are they likely to support long-term biodegradation?

_____ ____ Have rate constants or biodegradation rates been calculated?

_____ ____ Is the estimated time to achieve remediation objectives reasonable?

_____ ____ Is there a current or future threat to potential receptors?

**Detailed Evaluation – Groundwater Contamination**

**Answer** **Page #**

_____ ____ Has comprehensive, 3-dimensional site characterization been completed?

_____ ____ Has the hydraulic conductivity of the most permeable transport zone been measured?

_____ ____ Has the retarded contamination transport velocity been estimated?

_____ ____ Has the propensity for plume diving been determined?

_____ ____ Have contaminants of concern been measured for all monitoring points?

_____ ____ Have geochemical parameters been measured for all monitoring points?

_____ ____ Have isopleth maps been prepared for each parameter?

_____ ____ Have rate constants or biodegradation rates been calculated?

_____ ____ Is the estimated time to achieve remediation objectives reasonable?

_____ ____ Is there a current or future threat to potential receptors?

**Long-Term Performance Monitoring – Soil Contamination**

**Answer** **Page #**

_____ ____ Does the monitoring schedule extend for 1-2 years past when remediation objectives are expected to be achieved?

_____ ____ Is sample collection frequency at least biannually?

_____ ____ Are a sufficient number of locations to be sampled?

_____ ____ Are samples to be analyzed for contaminants of concern (BTEX, PAH, etc.)?

_____ ____ Are supplemental soil gas samples to be collected and analyzed?

**Long-Term Performance Monitoring – Groundwater Contamination**

_____ ____ Does the monitoring schedule extend for 1-2 years past when remediation objectives are expected to be achieved?

_____ ____ Is sample collection frequency at least quarterly for the first two years?

_____ ____ Is sample collection frequency after the first two years at most annually?

_____ ____ Are a minimum of 3 transverse plume transects, 1 upgradient transect, and 1 plume centerline transect scheduled to be sampled every sampling event?

_____ ____ Are all sentinel wells (if any) scheduled to be sampled every sampling event?

_____ ____ Are samples to be analyzed for contaminants of concern (BTEX, PAH, etc.)?

_____ ____ Are supplemental samples to be analyzed for geochemical indicators and degradation products?

**EXAMPLE PUBLIC NOTICE**

Kentucky Department for Environmental Protection
Division of Waste Management
Underground Storage Tank Branch
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

NOTIFICATION OF PROPOSED CORRECTIVE ACTION PLAN

The _____ (site name and Agency Interest number), located at _____ (address: street, city, county, Kentucky) has proposed a plan to clean up _____(type of contaminant) contamination from the _____(impacted media).

Due to a UST system release of _____(type of substance), a site investigation has been completed to determine the horizontal and vertical extent of contamination in the environment.

Proposed corrective action measures include _____ (technology or technologies to be used).

The Energy and Environment Cabinet proposes to accept the Corrective Action Plan. This decision is based on a thorough review of site conditions, Kentucky statutes and regulations.

Copies of the Corrective Action Plan are available from the UST Branch at the above address or by contacting the Records Custodian for the UST Branch at 502-564-5981. Persons wishing to submit written comments on the Corrective Action Plan should direct them to the cabinet within thirty (30) days after publication of this notice.

Upon request, the cabinet will provide a copy of the Corrective Action Plan in an alternate format.